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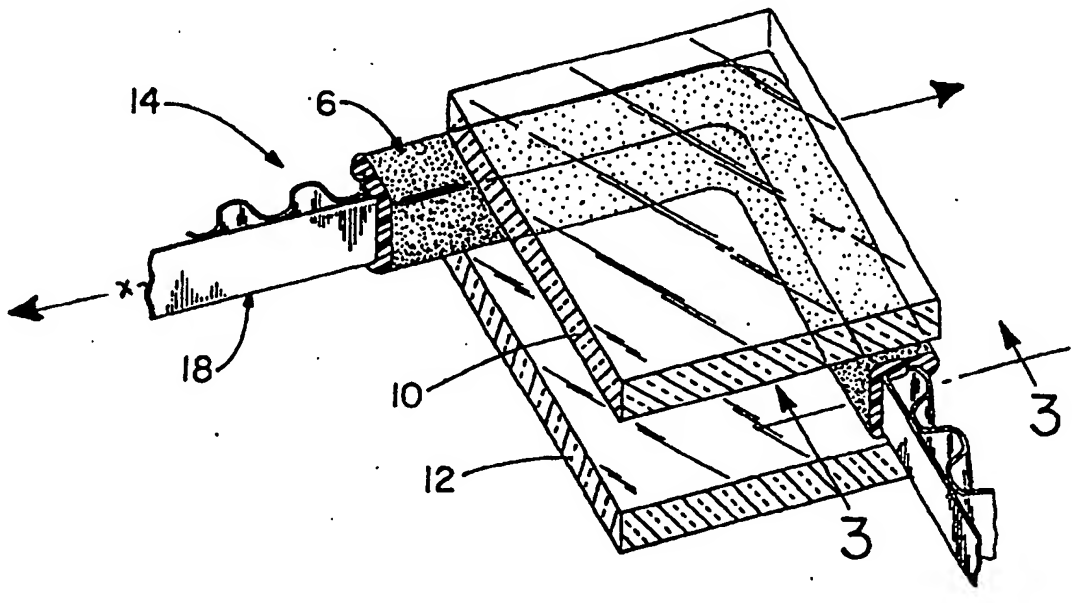

(57) Abstract

Flexible, crush-proof sealant and spacer strip (14) comprising an undulating spacer member, a coextending moisture vapor barrier means, and a deformable adhesive member (6) or members which hermetically seal the sealant and spacer strip (14) between substantially coplanar substrates (10, 12) to form a laminate such as a window.

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CONTINUOUS FLEXIBLE SPACER ASSEMBLY

FIELD OF INVENTION

This invention relates to structural sealants which can be used particularly in the fabrication of thermal insulating laminates such as windows.

BACKGROUND OF INVENTION

In general, the procedure for assembling a multiple glazed structure involves placing one sheet of glass over the other in a fixed, spaced relationship, and then injecting a sealant composition into the space between the two sheets of glass, at and along the periphery of the two sheets, thereby forming a sandwich structure having a sealed air pocket.

Heretofore the means employed for maintaining the spacing between the sheets of glass was either of a temporary, removable nature, or of a permanent nature. Exemplary of temporary removable spacer means are those disclosed in U.S. Patents Nos. 2,275,812 and 3,097,061. U.S. Patents Nos. 3,758,996 and 4,113,905 show embodiments of permanently installed spacer means. U.S. Patent No. 3,758,996 also teaches the concept of incorporating a desiccant within the spacer means. The desiccant functions as a medium upon which moisture and organic materials in the sealed air pocket are absorbed. This prevents the moisture from condensing on and fogging the interior surfaces of the sheets of glass.

In practicing the teachings of the prior art, multiple steps are required. Where a removable spacer means is employed, the spacer means must be set in place, the sealant injected, the sealant cured, and the spacer means thereafter removed. Where a permanent spacer means is employed, an adhesive is applied to secure the permanent spacer to the glass sheets, the spacer is set in place, and a sealant is then injected into the peripheral channel formed between the spacer and the edges of the sheets of glass.

These prior art practices are cumbersome, labor intensive, and expensive. An answer to the previously discussed limitations is provided by U.S. Patent No. 4,431,691, to Greenlee, which illustrates a sealant and spacer strip having a folded or contoured spacer means to maintain the relative distance under compression of glass sheets, wherein the strip comprises a folded or contoured spacer means embedded or enveloped in a deformable sealant. This spacer strip has the advantage of being flexible along its longitudinal axis to enable it to be coiled for storage.

However, there remains a need for an improved sealant and spacer strip that eliminates longitudinal stretching and, accordingly, makes it easier to consistently produce a window having a smooth sight line, i.e., along the lateral surface of the sealant and spacer strip in the direction of its longitudinal axis. Moreover, it would be desirable if such strips would allow for sharper (i.e., smaller radius) corners of the sealant and spacer strip, improved lateral stability of the strip, and provide a more cost-effective product.

Thus, the sealant and spacer strip of the present invention presents the advantages over the prior art of eliminating the amount of necessary sealant material while maintaining the performance of the sealant and spacer strip; eliminating the tendency of the material to stretch along its longitudinal axis; improving the appearance of the sight line of the window which is made using the sealant strip of the present invention; and improving the compressive strength of the sealant strip.

Additionally, it would be highly desirable to provide a sealant and spacer strip which requires less sealant material than known strips while achieving comparable performance which reduces the tendency of the material to stretch along its longitudinal axis, and which has an improved appearance and improved compressive strength. It is also desirable to provide a product which

achieves a tighter radius corner than achieved by the prior art products.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide an improved, longitudinally flexible (i.e., a strip which can be coiled) but laterally stable sealant and spacer strip for application in the assembly of multiple glazed structures as well as for other laminates.

It is a further object of the invention to provide a unitary structure which functions as a sealant and spacer and optionally as a desiccant which includes means for positively controlling and maintaining the spacing between two members in contact with the strip.

Another object of the invention is to provide a method for making a window having a stretch-resistant sealant and spacer strip and which eliminates the surface undulations which can occur in the sight line of a window made with sealant and spacer strips of the prior art if that spacer strip is subjected to excess stresses in the longitudinal direction. The invention also relates to a glazed window having smaller radius corners.

In accordance with one aspect of the present invention, there is provided a flexible, crush-resistant sealant and spacer strip or composite tape structure comprising a longitudinally extending spacer, including an undulating strip of rigid material, and a longitudinally coextending planar strip of rigid material which preferably is intermittently joined to one side of the undulating strip, and which together define a series of adjoining hollow cells. The moisture vapor barrier means includes at least at its top and bottom edges longitudinally extending ribbons (which can be joined together to form a single unit) of deformable adhesive sealant which seals the parallel substrate surfaces, the moisture vapor barrier means, and the spacer means to form a unit. The spacer means is undulating or contoured so as to be capable of

resisting compressive forces exerted in a direction normal to a plane in which the longitudinal axis of the spacer means lies, and the spacer means is preferably intermittently adhered to the moisture vapor barrier means to inhibit stretching of the sealant and spacer strip along its longitudinal axis and to enhance the appearance of the sealant and spacer strip along the long surfaces of the window as well as in the corners.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a fragmentary perspective view with parts in section showing a first embodiment of a window made in accordance with the present invention;

FIG. 2 is a fragmentary perspective view of a spacer means in accordance with the present invention;

FIG. 3 is a cross-section of the sealant and spacer strip of FIG. 1;

FIG. 4 is a perspective view of an alternate embodiment of the spacer means in accordance with the present invention;

FIG. 5 is a perspective view of the spacer means in accordance with the preferred embodiment of the present invention;

FIG. 6 is a perspective view of a third alternate embodiment;

FIG. 7 is a perspective view of a fourth alternate embodiment;

FIG. 8 is a perspective view of a fifth alternative embodiment; and

FIG. 9 is a fragmentary perspective view of a corner made from a sealant and spacer strip with the sealant cut away to show the corner.

DETAILED DESCRIPTION

Referring now to the drawings, it will be seen that FIG. 1 illustrates a composite structure comprising first substrate member 10 and second substrate member 12

having facing, generally parallel surfaces. First and second substrate members 10 and 12 are generally glass panes of a multiple glazed structure. The substrate members are joined together to form an enclosed space which is hermetically sealed by a composite tape structure, i.e., sealant and spacer strip 14, which includes sealant means 6 which at least partially envelopes a spacer assembly 18. Members 10,12, as illustrated, are formed of glass. However, it will be appreciated that the invention has applicability in the environment of an unrestricted variety of construction or structural materials, including, for example, cement, concrete, brick, stone, metals, plastics, and wood.

In accordance with a preferred embodiment of the invention, the spacer assembly 18 includes an undulating strip rigid material, i.e., a "shim" 17, and a generally planar strip of rigid material, i.e., a "moisture vapor barrier" 19, which is coextending with, and preferably intermittently joined to, the undulating strip at the peak of each of the undulations on one side of the undulating strip. The resulting spacer assembly is generally characterized as a linear series of adjoining hollow columns which may comprise tubular or prismatic cells. Thus, the spacer assembly can loosely be referred to as "honeycombed." By "undulating," it is meant that the shim has a repeating contour which gives edge-to-edge structural integrity in the "y" direction, i.e., parallel to the long axis of the cells as illustrated in FIG. 3. The undulations may include folds, ribs, creases, and sinusoidal waves having a cross-sectional profile which can be curved or angular or any combination thereof.

A particularly favorable undulating shim profile includes flat surfaces which can be adhered to the moisture barrier strip 19. Further, the undulations provide the shim with a profile which is capable of resisting compressive forces in the "y" direction. Moreover, the spacer means is resistant to torque about the

longitudinal axis. Consequently, spacer means 18 is "crush-resistant," i.e., capable of resisting forces tending to reduce the spacing between members 10,12 during use. This aspect of the invention facilitates the use of this spacer sealant for bigger windows since the prior art spacer could tend to twist during assembly. It should be understood that it would be within the scope of the invention to construct the spacer means as a single unit having a generally planar face and solid columns.

The undulations are generally transverse to the longitudinal axis to ensure flexibility for coiling or winding about an axis in the "y" direction. The frequency of the undulations may range from 1 to about 10 per inch, preferably from about 2 to about 8 per inch, and most preferably from about 2 to about 5 per inch, while the total amplitude, i.e., thickness of the crest and trough together in the "z" direction, is from about 0.080 to about 0.300 inch with from about 0.080 to about 0.250 inch being preferred. At the narrow end of this range, the shim performs better if it is fully encased rather than partially encased in the sealant/adhesive means.

The shim 17 can be formed of any material having sufficient rigidity to resist compressive forces exerted in a direction normal to the parallel planes in which the edges of the undulating strip lies. Suitable materials include any of various metals such as steel and aluminum, and rigid plastics, with aluminum being particularly preferred.

In accordance with the present invention, the compressive load strength of the spacer means 18 is augmented by the presence of the moisture vapor barrier 19, which is coextensive with the spacer shim 17. The planar strip 19 is preferably adhered to the flat surfaces of the shim 17. One method of adhering the moisture barrier strip 19 and the shim 17 is for the moisture vapor barrier strip to include an adhesive layer which is

intermediate the moisture vapor barrier strip and the shim.

Suitable thicknesses for the moisture vapor barrier strip 19 (as practiced for the preferred embodiment metallic strip) range from about 0.001 to about 0.020 inch, preferably from about 0.001 to about 0.01 inch, and most preferably from about 0.001 to about 0.005 inch. The shim or undulating strip 17 has a thickness of from about 0.003 to about 0.020 inch, preferably from about 0.003 to about 0.015 inch, and most preferably from about 0.005 to about 0.010 inch.

The sealant means 6 seals the gap formed between the moisture vapor barrier 19 and the substrate surfaces. Thus at least the two longitudinal edges of the barrier 19 include longitudinally extending ribbons 3 of sealant which are of sufficient thickness to provide a moisture-impenetrable seal. In particular, the sealing means overlays the opposing edges of the moisture vapor barrier strip and the shim which is intermittently joined to the planar strip. The sealing means may also include a lateral face 5 so as to have generally a U-shaped cross-section.

Suitable dimensions for the composite sealant and spacer strip will depend upon the window construction with the length corresponding generally to the window perimeter length. The width corresponds to the space between the double panes minus the adhesive sealant. Generally, the spacer means 18 will extend substantially across the total width with a sealant gap ranging from 0 to 0.050 on either side of the space with typical commercial widths being from 5/16 inch to 1 inch.

Various configurations for the spacer means 18 are illustrated in FIGS. 3-8, with a particularly preferred embodiment illustrated in FIGS 4-8. In FIG. 4, the shim 117 has an angular profile with sharp crests or peaks 116 and sharp troughs or valleys 115. The embodiment of the shim 217 of FIG. 5 has sinusoidal crests 216 and

troughs 215. FIG. 6 presents a shim 317 having almost cylindrical crests 316 and flat troughs 315. FIG. 7 shows a shim 417 having truncated crests 416 and flat troughs 415, while FIG. 8 shows a shim 517 having rectangular crests 516 and troughs 515.

The undulating strip or shim can be manufactured by any of various methods. For example, it can be extruded, stamped, pressed, vacuum-molded, or crimped, depending upon the material used. The undulating strip of shim can be joined to the planar strip by any suitable means such as by welding, thermally fusing, joining with adhesives such as a PSA (pressure-sensitive adhesive), or by crimping the shim to the planar strip. The sealant can subsequently be applied to the spacer assembly such as by dipping, painting, injecting or extruding the sealant to the lateral edges of the spacer means. Desiccant is preferably carried in the sealant and the sealant/desiccant is applied to the edges and front surface of the spacer means in a single step.

The spacer assembly of the preferred embodiment, comprising an undulating strip intermittently secured to a planar strip to define a honeycomb or cellular structure, has several important advantages over the prior art. The columnar aspect of the spacer means improves its compressive strength and improves the resistance to torque along the longitudinal axis. Consequently, it is easier to use the product to make windows which have a long dimension. Moreover, the moisture vapor barrier acts as a longitudinally stable backing which inhibits the spacer means from stretching along its longitudinal axis. This helps to ensure a proper product tolerance and also reduces the possibility of surface undulations in the lateral visible surface (the sight line) of the sealant after window construction. The smooth appearance is further enhanced by the planar surface of the barrier strip which faces the enclosed portion of the multiple glazed window. In a preferred embodiment of the inven-

tion, the planar face is inboard of the undulating shim, i.e., the planar shim carries a sealant and/or desiccant along the sight line and a portion of the exterior of the shim is free from sealant. However, it should be understood that the spacer means may be reversed so that the undulations carry the sealant and/or desiccant and form the sight line, and the planar strip is substantially free from sealant and faces the exterior of the window. Finally, the undulations serve to displace sealant so as to reduce the sealant adhesive which is necessary to achieve an effective seal. Thus, the sealant can be carried by the lateral edges of the spacer means and can achieve a sufficiently wide adhesive contact with the window pane to effect good adhesion and a good moisture vapor seal. In accordance with the present invention, this can be achieved using significantly less sealant than is used in the prior art.

As previously noted, elongated ribbons of deformable sealant are carried by at least the lateral edges of spacer means 18. The thickness to which elongated ribbon extends beyond the surfaces and edges of spacer means 18 is not critical as an absolute measurement, but is important in terms of functional considerations. Thus, the thickness of the enveloping sealant extending beyond spacer means 18, at least in the plane subjected to compressive forces, must be sufficient to maintain a continuous sealing interface under the applied compressive forces, but insufficient to permit substantial distortion of the sealant and spacer strip under such applied compressive forces. There must be enough sealant to effect a seal, but not so much as to cause a disfiguring amount of displacement of the sealant in the area bridging the surfaces of the two panel members.

For most applications, where the surfaces of the two members being sealed are relatively smooth, the thickness of the sealant extending beyond the spacer means should be in the range of 0.05-0.15 inch.

Because the surfaces of tempered glass may not be as flat as the surfaces of untempered glass, somewhat greater thicknesses may be required to provide tempered glass with an adequate seal. Where the surfaces of the two members being sealed are rough, as for example in the case of concrete, thicknesses as high as 0.25 inch or more may be needed to effect a seal.

The term "deformable" as used herein, is intended to characterize a sealant, whether thermoplastic, thermosetting, or thermoplastic-thermosetting, which when used in the fabrication of composite structures contemplated by this invention, is at least initially incapable of resisting deforming forces exerted upon it. Thus, the term "deformable" is intended to characterize a material which is in an uncured state and is incapable of resisting deforming forces exerted upon it, even though upon curing it is capable of resisting such forces. Further, the term "deformable" is intended to characterize a sealant which is initially incapable of resisting the compressive forces exerted upon it, and remains so throughout its useful life.

A wide variety of materials may be used as the deformable sealant, including polysulfide polymers, urethane polymers, acrylic polymers, and the styrene-butadiene polymers. Included among the latter are a class of thermoplastic resins which, when below their flow temperature, exhibit elastic properties of vulcanized polymers. Such resins are sold by Shell Chemical Co. under the trademark "Kraton." A preferred class of sealants is butyl rubbers.

Where the present invention is employed in the fabrication of multiple glazed, transparent, acoustic or thermal insulating windows formed of glass or plastic, it may be desirable to use a desiccant for the reason described above. Conveniently, the desiccant can be incorporated within the deformable sealant matrix and this can be applied to the front face of the sealant strip or,

alternatively, a different matrix can be used and co-extruded or otherwise applied to the sight line of the spacer means 18. A particularly suitable class of materials for this purpose is synthetically produced crystalline zeolite sold by UOP Corporation under the name "Molecular Sieves." Another desiccant which may be used is silica gel. Combinations of different desiccants are also contemplated.

In a preferred embodiment, the back or exterior face of the sealant strip is substantially free from sealant and more particularly is substantially free from sealant which includes a desiccant. By "substantially free" it is meant that at least one-third and more preferably one-half or even three-fourths (depending on the ultimate window gap width) of the surface of the spacer means is free of sealant 16. Thus, at each edge the sealant extends from about 0.05 to about 0.15 inch beyond the spacer means, and the necessary amount of sealant is reduced substantially. As is shown in FIG. 3, the sealant is advantageously U-shaped before it is applied to the window. Thus, the sealant/desiccant extends along the lateral face of the spacer means, i.e., the sight line, and along the lateral edge, i.e., the bond line.

An additional advantage of the configuration of spacer means 18 illustrated in FIG. 1, is that it permits the sealant and spacer strip 14 to be bent readily around corners as shown in FIG. 9. This capability is particularly desirable where the sealant and spacer strip is employed in the fabrication of multiple panel units which act as a thermal insulating barrier, e.g., double-glazed thermal insulating windows. In such units, the air space between the two panel members is sealed from the atmosphere. The fewer joints which are employed in establishing the seal, the less is the risk of failure of the seal, which failure is most likely to take place at a joint. Since the sealant and spacer strip 14 can be bent around

corners, a peripheral seal can be effected with only one joint.

FIG. 9 illustrates a corner 35 in accordance with the present invention with the spacer means 18 comprising the undulating shim 17 and the moisture vapor barrier 19. The barrier 19 collapses into a crest of the shim 17 drawing sealant into the hollow area 21 formed between the crest of the shim 17 and the barrier 19. This provides a smaller radius corner and eliminates the prior art problem of bulging, displaced sealant at the corner. Consequently, the resulting window has an improved appearance.

The preferred method of manufacturing the sealant and spacer strip in accordance with the present invention is by coextrusion. This can be accomplished with commercially available coextruding equipment which, in some instances, may require minor modification. In general, a previously formed or immediately pre-formed spacer means is fed through the center of an extrusion die and the deformable sealant is extruded about the spacer means leaving the exterior surface substantially free from sealant. The composite material is then fed through a sizing die to obtain a sealant and spacer strip having the desired outside dimensions and the proper thickness of sealant extending beyond the spacer means.

Alternately, the sealant may be extruded into both edges of the pre-formed spacer means and a material may simultaneously or sequentially be applied to the front lateral surface of the spacer, such as by co-extrusion, coating, or other lamination techniques. This material may be a different material from the edge sealant adhesive and may be formulated for aesthetic purposes, for desiccating purposes, or other reasons.

While in accordance with the patent statutes the best mode and preferred embodiment has been set forth, the scope of the invention is not limited thereto, but rather by the scope of the attached claims.

WHAT IS CLAIMED IS:

1. A spacer and sealant strip, comprising;

moisture vapor barrier means having a longitudinal axis and a planar surface bounded by top and bottom edges and cooperating with longitudinally coextending shim means having an undulating surface, said top and bottom edges each supporting adhesive means and moisture vapor sealant means.

2. A spacer and sealant strip according to Claim 1, wherein said undulating surface has a longitudinally extending area substantially free from said sealant means.

3. A spacer and sealant strip according to Claim 2, wherein said planar surface is a surface which includes a desiccant.

4. A spacer and sealant strip according to Claim 3, wherein said sealant means is further carried on said planar surface.

5. A spacer and sealant strip according to Claim 4, wherein at least the sealant means supported by the front surface includes a desiccant.

6. A spacer and sealant strip according to Claim 5, wherein said moisture vapor barrier means comprises a substantially planar metal ribbon which coextends with said shim means.

7. A spacer and sealant strip according to Claim 6, wherein said moisture vapor barrier and said shim means comprise metal and said moisture vapor barrier has a planar surface and said shim means includes transverse

undulations and periodic flat surfaces and said back surface is adhered to said periodic flat surfaces.

8. A laminate comprising a first sealing surface and a second substantially parallel sealing surface joined by a sealant and spacer strip which comprises a planar first strip adhered to a corrugated second strip and said first strip having a lateral surface separating a first and a second longitudinal edge respectively opposing and being joined to said first and said second sealing surfaces by sealant means, and said lateral surface including desiccant means.

9. A laminate according to Claim 8, wherein said first strip is metal and said lateral surface includes desiccant means in a matrix of said sealant means.

10. A laminate according to Claim 9, wherein said sealant means comprises butyl rubber.

11. A laminate according to Claim 8, wherein said laminate is a window.

12. A process for forming a spacer sealant strip for joining and hermetically sealing two substantially parallel surfaces comprising the steps of;

forming spacer means extending along a longitudinal axis and having opposing edges by crimping a first metal ribbon to form corrugations transverse to the longitudinal axis and joining said crimped ribbon to a lateral surface of a metal strip; and

applying a deformable adhesive and sealant to at least said opposing longitudinal edges.

13. The process of Claim 12, wherein said first metal ribbon is adhered to said planar strip.

14. The process for forming a spacer sealant strip according to Claim 13, wherein said sealant is applied by extruding it onto the spacer means.

15. The process for forming a spacer sealant strip according to Claim 14, wherein said sealant is also extruded onto the front lateral surface of the second ribbon.

16. The process for forming a spacer sealant strip according to Claim 15, wherein the sealant includes a desiccant.

17. A composite tape for maintaining parallel substrates in spaced relationship to each other and for sealing a volume between said spaced substrates, comprising:

a spacer assembly including an undulating strip of rigid material and a planar strip of moisture vapor impenetrable material intermittently joined to said undulating strip, whereby said joined undulating and planar strips together define a series of adjoining cells; and deformable adhesive sealant means extending along the opposing edges of the undulating strip and overlaying the undulating surface of the undulating strip opposite of the side which is intermittently joined to said planar strip.

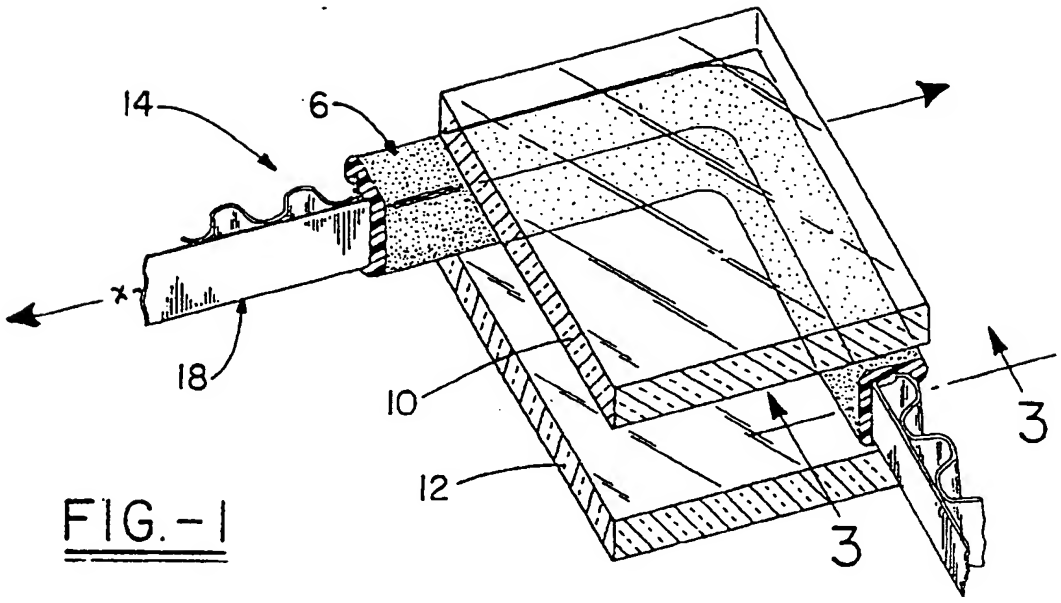

FIG.-1

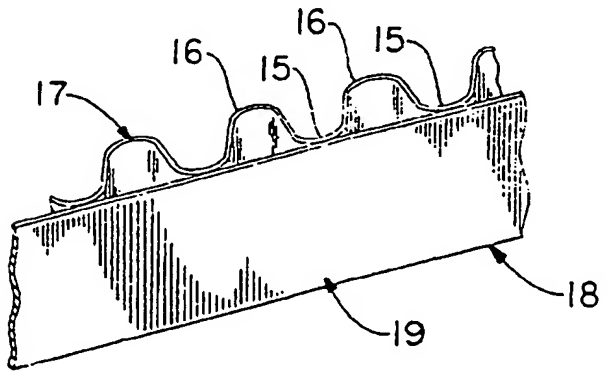

FIG.-2

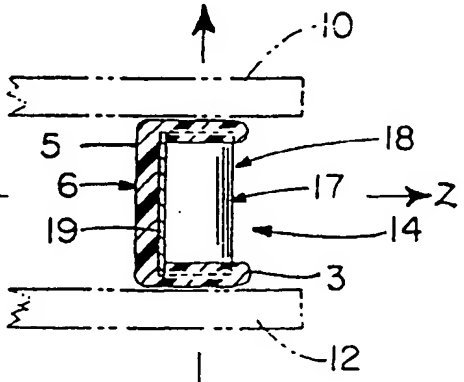

FIG.-3

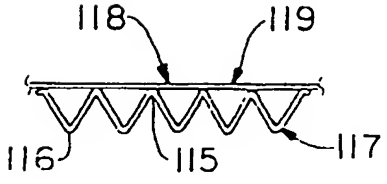

FIG.-4

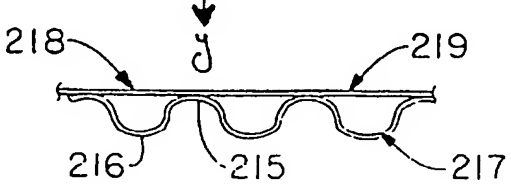

FIG.-5

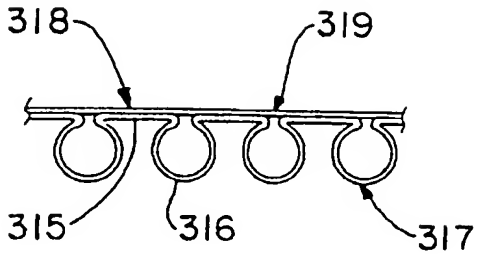

FIG.-6

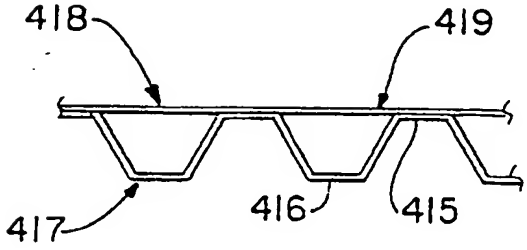

FIG.-7

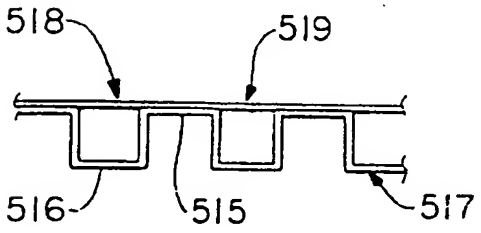

FIG.-8

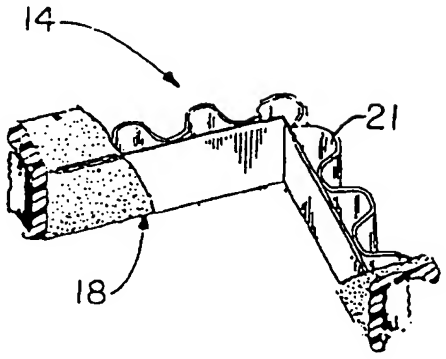

FIG.-9

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 97/00258

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E06B3/663 E06B3/677

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E06B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 0 500 483 A (VITROLAN) 26 August 1992 see column 1, line 20 - line 56 see column 4, line 16 - column 6, line 36 see figures ---	12,13,17 1,3-11, 14-16
Y	FR 2 379 691 A (BFG GLASSGROUP) 1 September 1978 see page 16, line 4 - line 25; figure 6 ---	1,3-11
Y A	US 4 431 691 A (GREENLEE) 14 February 1984 cited in the application see column 3, line 60 - column 6, line 53; figures 1,2 ---	14-16 1,3-5, 8-11
A	AT 379 860 B (STEINLEITNER) 10 March 1986 see the whole document --- -/--	1,2,6-9, 11-13,17

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 May 1997	20. 05. 97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Authorized officer Depoorter, F

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INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 97/00258

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DE 19 04 907 A (BOSTIK) 13 August 1970 see page 2, paragraph 1 - page 3, paragraph 2 see page 4, paragraph 1 - page 6, paragraph 1 see figures	1,6-8, 10-12,17
A	GB 2 023 209 A (BOSTIK) 28 December 1979 see page 5, line 4 - line 34 see page 5, line 81 - line 96 see figures 1-7	2,14
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INTERNATIONAL SEARCH REPORT

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